

Automation of Black Board duster for Ergonomics and Chalk dust suppression

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Abstract – Blackboard and chalk piece are an indispensable part of a classroom, no matter how smart our classrooms have become. Erasing the board with a duster generates a fine suspension of chalk dust in the vicinity of the board, which is constantly inhaled by the teacher as well as the students near the board. Though this doesn't appear serious, prolonged inhalation will result in breathing trouble. Hence automation of the board erasing process is attempted along with a mechanism for suction, which suppresses the dispersion of chalk dust in air. It is planned to implement this in our college class rooms on a step by step basis.

Key Words: Automation of blackboard eraser, suction chamber suppressing chalk dust suspension

1.INTRODUCTION

The usage of blackboard and chalk piece is almost used in every educational institution in the world. Cleaning the board using a duster / black board eraser is mandatory for continuing the writing process and this involves rubbing a foam / sponge surface against the board surface. This not only cleans the board but also creates a fine dispersion of chalk powder all around, which is certain to be inhaled by the teacher and in many cases students who occupy seats near the black board. Chi-Chi Lin et al [1] have carried out a study on the particle size distribution of chalk dust suspension in a classroom with standard ventilation conditions. It was concluded by them that best way to get rid of the suspension is to use ceiling fans while opening the windows, which proved to be better than mechanical ventilation. The work also concluded that teachers were at the maximum risk of inhaling the chalk dust and the maximum particle concentration occurs in the classroom while rubbing the board using a duster. M. Fayez-Hassan [2] has shown that the suspended chalk dust contains calcium and traces of aluminium, iron, magnesium and silicon by using fast neutron analysis and X-ray fluorescence technique in a standard class room atmosphere. The outcome of this study is that when concentration levels of the chalk dust suspension exceeds a safe limit; occupants of the class room especially the teacher are exposed to serious health hazards. Consuming the chalk dust through mouth does not pose any serious problem, but prolonged inhalation proves to be

hazardous. Usage of dustless chalks proves less hazardous since the particles in this are much heavier and settle down fast rather than forming a suspension. Kamini D. Nikam & Munira A. Hirkani [3] have shown that teachers exposed to prolonged chalk dust environment are at a serious risk of developing pulmonary function impairment and the authors urge such teachers to shift to white board and marker. The study was conducted on 15 participants and measurement was made using peak flow measurement device on the respiration of the participants. Hazard Prevention and Control in the Work Environment: Airborne Dust [4] released by the World Health Organisation (WHO) rate the chalk dust at third rank in the order easiness with which the particles form a suspension in air, among many materials which were tested. Also a detailed study covers how particle diameter determines where the particles get deposited along respiratory tract. Also it was proven that breathing through mouth results in more particle deposition in the lungs rather than nasal breathing, since nasal passage are filtered by mucus membrane layer lined with hairs which enhance filtering of dust. Sunil R. Kewate et al [5] have designed an intelligent dust collection device that mechanically remove the saturated dust present in the duster by hitting against a perforated blocks. The dust released during this process is suppressed through suction action of a suction pump, through the holes of the perforated blocks. Such intelligent system proves very effective in minimising the class room air quality since removing the dust from the eraser generates a fine dispersion around the zone. With these literatures in mind it was decided that keeping the teacher far away from the board while rubbing it minimises the risk of inhaling to the teacher. This can be done by automating the board erasing using a specifically designed duster, coupled with suction capability to minimise suspension of chalk dust is taken up as the objective of this work. Such a device is expected to improve the air quality in class rooms, thus minimising health hazards to students and especially teachers.

2. Design and Fabrication of automatic Black Board Eraser:

The aim of this work is to keep the teacher or student away from the board while it is being erased, in order to minimize the inhalation of chalk dust particles which are suspended in the air around the black board while it is rubbed. Maximum concentration of suspension occurs while board is rubbed

and so it makes a good sense to make an attempt in automating the rubbing process. The automatic device consists of a rather long black board eraser casing, which can hold multiple standard erasers. The length of this casing must be equal to one of the dimensions of the board, either its length or breadth, in order to cover the entire board in a single stroke. The casing is provided with perforations on the surface which face the duster, enabling suction action to suppress the air suspension of chalk dust. The dust collection is done using a standard domestic vacuum cleaner and is collected in a separate chamber. The design and fabrication of various parts of the automatic black board eraser are as follows;

2.1 Rack and Pinion:

A standard rack and pinion is used as a means of controlling the instantaneous position of the eraser. The rack is connected to the duster casing on one end and is in mesh with the pinion. The pinion is driven using a standard 12V motor and the pinion in turn drives the rack. Controlling the motor enables the control of the position of the duster. To overcome problems related to corrosion and lubrication plastic gears of high strength and durability are employed. A schematic arrangement of the position of the rack and pinion is shown below.

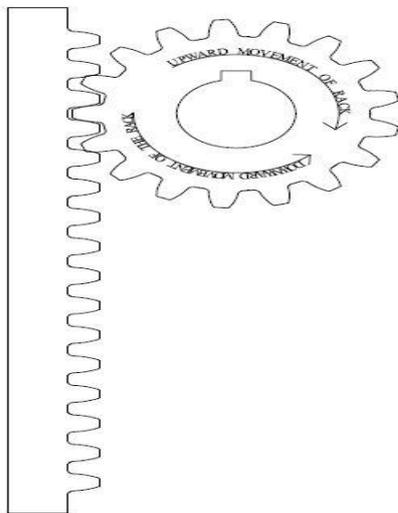


Figure 1: Rack and pinion arrangement

2.2 Casing with perforations:

The casing is the most crucial part of the assembly. It runs along the entire horizontal length of the black board. The casing holds a vacuum chamber within itself. The surface of the casing facing the board, which holds the duster, has many perforations which facilitate the suction of chalk dust into the vacuum chamber. The back surface of the casing has an opening which is connected to a standard vacuum cleaner through a flexible hose. A schematic of the casing is shown below.

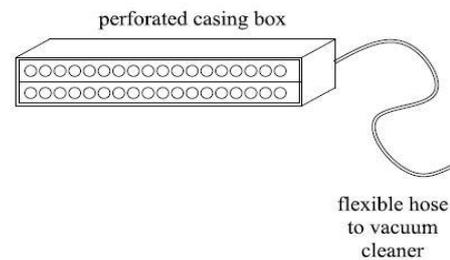


Figure 2: Schematic representation of the casing

The casing is fabricated out of 0.5mm GI sheet and the parts are riveted together. A hole is made on the back side and is fixed with a check valve to facilitate the suction process.

2.3 Guide Ways:

The casing is fixed onto a horizontal member, which rests on a pair of guide ways on either side of the black board. The guide ways are provided with telescopic linear motion bearings, which provide a low friction yet a steady movement of the eraser. The guide ways are provided with limiting switches at the top and bottom ends. These switches serve to reverse polarity of the current supplied so that, the motor reverses as the duster reaches top or bottom.

2.4 Vacuum Cleaner:

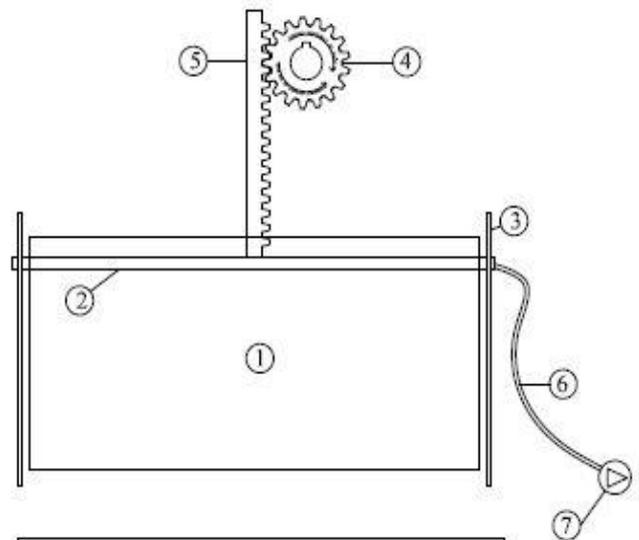
A standard domestic purpose vacuum cleaner is used for the purpose of sucking the chalk dust out of the eraser through the vacuum chamber of the casing. Though operation is a bit noisy, the fact that the cleaner need not be operated always while the board is rubbed comes in handy. When the quality of erasing decreases, due to saturation of chalk dust in the foam, the vacuum cleaner shall be switched on to suck out the dust. On an average the duster needs to be cleaned twice a day at the most. This can be done during end of each class or during breaks, which totally avoids noise during lecture hours.

2.5 DC Motor:

Standard DC 12V motor is used for driving the pinion. The limiting switches are connected to the motor which rotates in reverse direction, on reaching top or bottom extreme of the board. The motor is rigidly fixed on to the wall above the black board using wooden block, since any movement in the position of the motor disturbs the meshing of pinion with the rack. A photograph of the DC motor used in the setup is shown below.



Fig 3: DC motor and pinion assembly



LEGEND	
PART NO	DESCREPTION
①	BLACK BOARD
②	CASING WITH VACUUM CHAMBER
③	TELESCOPIC GUIDE WAYS
④	DC MOTOR & PINION ASSEMBLY
⑤	RACK
⑥	FLEXIBLE HOSE
⑦	VACUUM CLEANER

Fig 4: Assembly of components

3. Results and Discussion:

A schematic representation of the entire assembly is shown below.

The casing consisting of multiple erasers stacked together moves up and down, erasing the entire area of the black board in a single stroke. Erasing process shall be repeated until a desired quality of cleaning is achieved. With the installation of the duster in one of our college class rooms, erasing board has become very ergonomic. Also the dust suspension appears to have reduced compared to manual board cleaning. The cleaning quality is uniform thought the entire area of the board since it is done mechanically in a single stroke. It was observed that if vacuum cleaner was used every time while rubbing the board, dust dispersion in the air around appears far lesser, than without operation of the vacuum cleaner. All these observations indicate that such an automatic board eraser system is apt and is very much necessary for all

educational institutions, and they serve to minimize time and effort. Also they curtail the dispersion of chalk dust in the air, protecting the teacher as well as the students from its ill effects.

4. Conclusion:

After the testing of the system in a class room the following conclusions are made

1.The automatic eraser is very efficient in the board erasing process, saving human effort. The suspension of chalk dust appears to have reduced by the feel of teachers and students.

2. A detailed study needs to be undertaken on the particle size distribution and concentration of chalk dust suspension in the room, when using the duster with and without switching on the vacuum cleaner

3. The existing foams used in place of duster, has poor permeability in letting the chalk dust diffuse through them into the vacuum chamber. Hence a new type of material has to be developed for efficient functioning of the dust collection system, which is very crucial for the suppression of air suspension of chalk dust.

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